

being laid in a heap, are covered with other elixed or drained Ashes, the better to keep them warm; which is reiterated, as long as they make *Brimstone*.

To make *Coperas* or *Vitriol*, they take a quantity of the said Ashes, and throwing them into a square planked pit in the Earth, some four foot deep, and eight foot square, they cover the same with ordinary water, and let it lye twenty four hours, or untill an Egge will swim upon the liquor, which is a sign, that it is strong enough. When they will boyl this, they let it run through Pipes into the Kettles, adding to it half as much Mother-water, which is that water, that remains after boyling of the hardned *Coperas*. The Kettles are made of Lead, $4\frac{1}{2}$ foot high, 6 foot long, and 3 foot broad, standing upon thick Iron Barrs or Grates. In these the Liquor is boyled with a strong Coal-fire, twenty four hours or more, according to the strength or weakness of the Lee or Water. When it is come to a just consistence, the fire is taken away, and the boyled liquor suffered to cool somewhat, and then it is tapp'd out of the said Kettles, through holes beneath in the sides of them, and conveyed through wooden Conduits into several Receptacles, three foot deep and four foot long (made and ranged not unlike our Tan-pits) where it remains fourteen or fifteen dayes, or so long till the *Coperas* separate it self from the water, and becomes icy and hard. The remaining water is the above-mentioned Mother-water; and the elixed or drained Ashes are the Dreggs, or *Caput mortuum*, which the Lee, whereof the *Vitriol* is made, leaves behind it in the planked Pitts.

A further Account of Mr. Boyle's Experimental History of Cold.

In the first Papers of these *Philosophical Transactions*, some promise was made of a fuller account, to be given by the next, of the *Experimental History of Cold*, composed by the Honourable Mr. Robert Boyle; it being then supposed, that this *History* would have been altogether printed off at the time of publishing the *Second Papers*

Papers of these *Transactions* ; but the Press, employed upon this Treatise, having been retarded somewhat longer than was expected, the said promise could not be performed before this time : wherein it now concerns the inquiring World to take notice, that this subject, as it hath hitherto bin almost totally neglected, so it is now, by this Excellent Author, in such a manner handled, and improved by near *Two hundred* choice *Experiments* and *Observations*, that certainly the *Curious* and *Intelligent* Reader will in the perusal thereof find cause to admire both the Fertility of a Subject, seemingly so barren, and the Author's Abilities of improving the same to so high a Degree.

But to take a short view of some of the particulars of this *History*, and thereby to give occasion to *Philosophical* men, to take this Subject more into their consideration, than hitherto hath been done ; the Ingenious Readers will here see,

1, That not only all sorts of *Acid* and *Alcalizate* Salts, and Spirits, even Spirit of Wine ; but also Sugar, and Sugar of Lead mixed with Snow, are capable of freezing other Bodies, and upon what account they are so.

2, That among the Substances capable of being frozen, there are not only all gross sorts of Saline Bodies, but such also as are freed from their grosser parts, not excepting Spirit of Urine, the *Lxivium* of Pot-ashes, nor Oyl of Tartar, *per deliquium*, it self.

3, That many very spirituous liquors, freed from their aqueous parts, cannot be brought to freeze, neither naturally, nor artificially : And here is occasionally mentioned a way of keeping *Moats* unpassable in very cold Countries, recorded by *Olaus Magnus*.

4, What are the ways proper to estimate the greater or lesser Coldness of Bodies ; and by what means we can measure the intensity of Cold produced by Art, beyond that, which Nature needs to employ for the freezing of Water ; as also, in what proportion water of a moderate degree of Coldness will
be

be made to *shrink* by Snow and Salt, before it begin by Congelation to *expand* it self; and then, how to measure by the differing Weight and Density of the same portion of Water, what change was produced in it, betwixt the hottest time of Summer, and first glaciating degree of Cold, and then the highest, which our Author could produce by *Art*: Where an Inquiry is annex'd, whether the making of these kind of Tryals with the waters of the particular Rivers and Seas, men are to sail on, may afford any useful estimate, whether or not, and how much, ships may on those waters be safely loaden more in Winter, than in Summer. To which is added the way of making exact Discoveries of the differing degrees of Coldness in differing Regions, by such Thermometers, as are not subject to the alterations of the *Atmosphere's* gravitation, nor to be frozen.

5. Whether in Cold, the diffusion from Cold Bodies be made more strongly downwards, contrary to that of Hot Bodies: Where is delivered a way of freezing Liquors without danger of breaking the Vessel, by making them begin to freeze at the bottom, not the top.

6. Whether that Tradition be true, that if frozen Apples or Eggs be thaw'd neer the Fire, they will be thereby spoil'd, but if immersed in cold water, the Internal Cold will be drawn out, as is supposed, by the External Cold; and the frozen Bodies will be harmlesly thawed? *Item*, Whether Iron, or other Metals, Glafs, Stone, Cheese, &c. expos'd to the freezing Air, or kept in Snow or Salt, upon the immersing them in Water will produce any Ice? *Item*, What use may be made of what happens in the different waies of thawing Eggs and Apples, by applying the Observation to other Bodies, and even to Men, dangerously nipp'd by excessive Cold. Where is added not only a memorable Relation, how the whole Body of a Man was successfully thawed and cas'd all over with Ice, by being handled, as frozen Eggs and Apples are; but also the Luciferousness of such Experiments as these: and likewise, what the effects of Cold may be, as to the Conservation or Destruction of the Textures of Bodies: and in particular, how Meat and Drink
may

may be kept good, in very Cold Countries, by keeping it under Water, without glaciation? as also, how in extreme Cold Countries, the Bodies of Dead Men and other Animals may be preserved very many years entire and unputrefied? And yet, how such Bodies, when unfrozen, will appear quite vitiated by the excessive Cold? Where it is further inquired into, whether some Plants, and other Medicinal things, that have specifick Vertues, will loose them by being thoroughly congealed and (several wayes) thawed? And also, whether frozen and thawed Harts-horn will yield the same quantity and strength of Salt and saline Spirit, as when unfrozen? *Item*, Whether the *Electrical* faculty of *Amber*, and the *Attractive* or *Directive* Virtue of *Loadstones* will be either impaired, or any wayes altered by intense Cold? This Head is concluded by some considerable remarks touching the operation of Cold upon Bones, Steel, Brasse, Wood, Bricks.

7, What Bodies are expanded by being frozen, and how that expansion is evinced? And whether it is caused by the intrusion of Air? As also, whether, what is contained in icy bubbles, is true and Springy Air, or not.

8, What Bodies they are, that are contracted by Cold; and how that Contraction is evinced? Where 'tis inquired, whether *Chymical Oyles* will, by Congelation, be, like expressed Oyles, contracted, or, like aqueous Liquors, expanded?

9, What are the wayes of *Measuring* the *Quantity* of the Expansion and Contraction of Liquors by Cold? And how the Au hor's account of this matter agrees with what Navigators into cold Climates, mention from experience, touching pieces of Ice as high as the Masts of their Ships, and yet the Depth of these pieces seems not at all answerable to what it may be supposed to be.

10, How strong the Expansion of freezing water is? Where are enumerated the several sorts of Vessels, which being filled

G

with

with water, and exposed to the cold Air, do burst; and where also the weight is expressed, that will be removed by the expansive force of Freezing? Whereunto an Inquiry is subjoined, whence the prodigious force, observed in water, expanded by Glaciation, should proceed? And whether this *Phænomenon* may be solved, either by the *Cartesian*, or *Epicurean* Hypothesis?

II. What is the *Sphere of Activity* of Cold, or the Space, to whose extremities every way the Action of a cold Body is able to reach: where the difficulty of determining these limits, together with the causes thereof, being with much circumspection mentioned, it is observed, that the *Sphere of Activity* of Cold is exceeding narrow, not onely in comparison of that of Heat in Fire, but in comparison of, as it were, the *Atmosphere* of many odorous Bodies; and even in comparison of the *Sphere of Activity* of the more vigorous Loadstones, insomuch, that the Author hath doubted, whether the Sense could discern a Cold Body, otherwise then by immediate Contract. Where several Experiments are delivered for the examining of this matter, together with a curious relation of the way used in *Persia*, though a very hot Climate, to furnish their *Conservatories* with solid pieces of Ice of a considerable thickness: To which is added an Observation, how far in Earth and Water the Frost will pierce downwards, and upon what accounts the deepness of the Frost may vary. After which, the care is inculcated, that must be had, in examining, whether Cold may be diffused through all *Mediums* indefinitely, not to make the Trials with *Mediums* of two great thickness: where it is made to appear, that Cold is able to operate through Metalline Vessels, which is confirmed by a very pretty Experiment of making *Icy Cups* to drink in; whereof the way is accurately set down. Then are related the Trials, whether, or how, Cold will be diffused through a *Medium*, that *some* would think a *Vacuum*, and which to *others* would seem much less disposed to assist the diffusion of Cold, than Common Air it self. After which follows a curious Experiment, shewing whether a Cold Body can operate through

a *Medium* actually hot, and having its heat continually renewed by a fountain of heat.

12, How to estimate the solidity of the Body of Ice, or how strong is the mutual adhesion of its parts? and whether differing Degrees of Cold may not vary the Degree of the compactness of Ice. And our Author having proceeded as far as he was able towards the bringing the strength of Ice to some Estimate by several experiments, he communicateth the information, he could get about this matter among the Descriptions that are given us of Cold Regions: And then he relateth out of Sea-mens *Journals*, their Observations touching the insipidness of resolved Ice made of Sea-water; and the prodigious bigness of it, extending even to the height of two hundred and fourty Foot above water, and the length of above eight Leagues. To which he adds some promiscuous but very notable Observations concerning Ice, not so readily reducible to the foregoing Heads: *videlicet*, Of the blew Color of Rocky pieces of Ice; and the horrid noise made by the breaking of Ice, like that of Thunder and Earthquakes, together with a Consideration of the Cause, whence those loud Ruptures may proceed.

13, How Ice and Snow may be made to last long; and what Liquor dissolves Ice sooner than others, and in what proportion of quickness the solutions in the several Liquors are made, where occasion is offered to the Author, to examine, whether Motion will impart a heat to Ice? After which, he relates an Experiment of *Heating* a Cold Liquor with Ice, made by himself in the presence of a Great and Learned Nobleman, and his Lady, who found the Glass wherein the Liquor was, so hot that they could not endure to hold it in their Hands. Next, it is examined, whether the effects of Cold do continually depend upon the actual presence and influence of the manifest Efficient Causes, as the Light of the Air depends upon the Sun or Fire, or other Luminous Bodies. To this is annexed an Account of the *Italian* way of making *Conservatories* of Ice and Snow, as the Author had received it from that Ingenious and Polite Gentleman, Master J. Evelyn.

But

But want of time prohibiting the accomplishment of the intended account of this Rich Piece: what remains, must be referred to the next Occasion. It shall only be intimated for a Conclusion, that the *Author* hath annexed to this *Treatise*, an Examen of Master *Hobs's* Doctrine touching *Cold*; wherein the *Grand Cause* of *Cold* and its Effects is assigned to *Wind*, in so much that 'tis affirmed, that almost any Ventilation and stirring of the Air doth refrigerate.

L O N D O N,

Printed with License, By *John Martyn*, and *James Allestry*, Printers to the *Royal-Society*. 1665.
